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Case Docket No. 60,426-048

Date: September 7, 2000

Box Patent Application
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Sir:

Transmitted herewith for filing is a patent application of

Inventor(s): Paul D. Daly

For: ELECTRIC VEHICLE CONTROL SYSTEM

Enclosed are:

X 1 sheets of drawings - ___ Formal X Informal
X An Assignment of the invention to Siemens Canada Limited
___ A certified copy of a _____ application.
X A Combined Declaration and Power of Attorney
___ An associate power of attorney.
___ A verified statement to establish small entity status under 37 CFR 1.9 and 37 CFR 1.27.
___ PTO Form 1449 with copies of patents cited in specification. (IDS).
X This application claims priority to Provisional Application No. 60/152,998 which was filed on September 9, 1999.

The filing fee has been calculated as shown below:

	No. Filed	No. Extra	Small Entity		Large Entity	
Basic Fee			$345		$690	$690
Total Claims	18-20		X 9	$	X 18	$
Indep. Claims	2-3		X 39	$	X 78	$
Multiple Dep. Claim(s) Present						$
			TOTAL		TOTAL	$

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X Checks in the amount of $690.00 to cover the filing fee
And $40.00 for the Assignment Recordation are enclosed. A duplicate copy of this sheet is enclosed.

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___ Any additional filing fees required under 37 CFR 1.16.

X Any patent application processing fees under 37 CFR 1.17.

Respectfully submitted,

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"EXPRESS MAIL" Mailing Label No. EL692367979US Date of Deposit September 7, 2000 I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner of Patents, Box Patent Application, Washington, D. C. 20231.

Cindy M. Foster

Cindy M. Foster

Docket No 60,426-043
99P7786

ELECTRIC VEHICLE CONTROL SYSTEM

RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 60/152,998, which was filed on September 9, 1999.

BACKGROUND OF THE INVENTION

This invention generally relates to electric vehicles. More particularly, this invention relates to controlling a motor response in an electric vehicle based upon vehicle characteristics.

Conventional gasoline powered vehicles are designed to provide some consistency in motor response to manual manipulation of an accelerator pedal. The driver prefers to experience the same vehicle performance or motor response given the same pedal actuation. This is possible regardless of the level of fuel in the fuel tank or the temperature of the engine, provided that each is within an operable range.

More recently, electrically powered vehicles, or electric vehicles as they are commonly known, have been introduced. One drawback associated with electric vehicles is that the design does not automatically lend itself to providing a driver with a consistent motor response to a given accelerator actuation. For example, at initial start up, the electric motor temperature typically is lower than after the vehicle has been driven for some time. It is known that electric motors typically are unable to perform at the same level as the motor temperature increases. Motor performance typically is hindered by the motor's ability to dissipate heat. Therefore, a driver typically experiences a more robust motor response to a given accelerator manipulation at vehicle start up compared to later after the vehicle has been driven for some time.

Another factor that hinders consistent motor response in an electric vehicle is the charge level in a fuel cell. Reduced charge levels can result in reduced motor performance even though there is enough power available to drive the vehicle.

There is a need for an improved control strategy to control the motor response in an electric vehicle so that power consumption is better managed and the driver experiences a more consistent motor response to a given actuation of the accelerator. This invention provides a system and method for controlling an electric vehicle motor response based upon vehicle characteristics such as motor temperature or fuel cell charge level.

SUMMARY OF THE INVENTION

In general terms, this invention is a system and method for controlling motor response in an electric vehicle that has a motor and a manually operable accelerator. The method of this invention includes several steps. First a vehicle characteristic, such as motor temperature, is monitored. The maximum power output available based upon the vehicle characteristic is determined. The motor response to a manipulation of the accelerator is adjusted based upon the determined maximum power. The adjustment to the motor response preferably is made to compensate for differences in motor performance as may be caused by the current state of the vehicle characteristic, such as motor temperature.

The various features and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the currently preferred embodiment. The drawings that accompany the detailed description can be briefly described as follows.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 diagrammatically illustrates an electric vehicle system designed according to this invention.

Figure 2a graphically illustrates a feature of this invention.

Figure 2b graphically illustrates the feature of Figure 2a under different conditions.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An electric vehicle system 20 includes an electric motor 22. A fuel cell 24 provides power to the motor. A controller 26 provides command signals to the motor to control the motor operation responsive to a driver manipulating an accelerator 28. Signal communication between the controller 26 and the accelerator 28 is schematically shown at 30.

The controller 26 preferably controls the motor response of the motor 22 to a given manipulation of the accelerator 28 so that the driver experiences consistent vehicle performance under different vehicle conditions. In one example, the controller 26 alters the gain associated with a signal provided to power the motor so that consistent motor response is achieved.

The controller preferably monitors a plurality of vehicle characteristics that may have an effect on motor performance or the maximum amount of power output available under given conditions. Example vehicle characteristics include the temperature of the motor 22, a charge level of the fuel cell 24 and current vehicle speed. Other characteristics or conditions that are determined to have an effect on motor power output are preferably also monitored using a system designed according to this invention.

For discussion purposes, the example of the motor temperature will be discussed in this specification. It is known that electric motor performance is limited by the ability to dissipate heat in the motor windings (and in some cases the rotor). Those skilled in the art who have the benefit of this description will be able to use other vehicle characteristics, alone or in combination, to control motor response in a manner similar to the described use of temperature information.

Figure2a shows a graphical plot 40 of a motor power signal curve 42 at a first motor temperature. For example, the temperature in Figure 2a is a relatively cool temperature at or near vehicle start up. Figure 2b shows a plot 44 of the motor power signal 46 at a second motor

temperature that is higher than the first temperature, which would occur after the motor has been running for some time. As can be appreciated from the drawings, the power signal at the second temperature is higher than that at the first temperature for some levels of accelerator manipulation. For example two accelerator pedal positions 50 and 52 are shown in each plot 40 and 44. At the first temperature, the power signal 42 has a magnitude at 54 when the accelerator is in the position 50. A higher signal value at 56 is provided at the second temperature. The same is true comparing the signal magnitudes at 58 and 60 for an accelerator position 52. The plots of the power signal shows the adjustment made dependant on the monitored motor temperature.

The controller 26 preferably is programmed or provided with a suitable look up table so that it adjusts the motor power signal, given the monitored characteristic. That way, the motor response is controlled in relation to the monitored temperature or other vehicle characteristic. The motor response or actual power output preferably is the same for the signals 42 and 46, respectively. The controller 26 controls the signal level to the motor 22 to control the motor response to be consistent for a given accelerator manipulation regardless of motor temperature.

A system designed according to this invention preferably also maximizes power usage in an electric vehicle by controlling the motor response based on current vehicle characteristics. Under some conditions, such as a lower motor temperature, a higher power output is available. The controller preferably is programmed to provide an indication to the driver that additional power is available. An indicator 70 provides a visible indication of the additional available power in one example. In another example, an audible signal or a combination of visible and audible feedback is provided to the driver. The indicator 70 preferably provides information such as the availability of additional power along with an amount of time within which it will be available under the current vehicle conditions.

A driver input 72 preferably is included that allows the driver to communicate with the controller 26 to obtain a modified motor response based on the availability of additional power

or to conserve energy within the fuel cell 24. In the illustrated example the input 72 is separate from the accelerator 28. In another example, the accelerator 28 can be manipulated to communicate a desire for modified motor response.

The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed embodiments may become apparent to those skilled in the art that do not necessary depart from the spirit or purview of this invention. The scope of legal protection given to this invention can only be determined by the following claims.

CLAIMS

I claim:

1. A method of controlling motor response in an electrically powered vehicle having a motor and a manually operable accelerator, comprising the steps of:

monitoring a vehicle characteristic;

determining a maximum available power output based upon the vehicle characteristic; and

adjusting a motor response to manipulation of the accelerator based upon the determined maximum power.

2. The method of claim 1, wherein the vehicle characteristic is heat in the motor.

3. The method of claim 2, including increasing the motor response as the determined heat increases.

4. The method of claim 3, wherein there is a gain associated with manipulation of the accelerator and including increasing the gain as the determined heat increases.

5. The method of claim 1, wherein the motor has a fuel cell and the vehicle characteristic is a charge level of the fuel cell.

6. The method of claim 5, including increasing the motor response as the determined

charge level decreases.

7. The method of claim 6, wherein there is a gain associated with manipulation of the accelerator and including increasing the gain as the determined charge level decreases.

8. The method of claim 1, including determining a first response level for a manipulation of the accelerator when the vehicle characteristic is a first condition and step (C) includes determining an adjustment to the motor response necessary to obtain the first response level for the same manipulation of the accelerator when the vehicle characteristic is a second condition.

9. An electric vehicle power control system, comprising:

an electric motor;

a manually operable accelerator; and

a controller that controls a response of the motor to a manipulation of the accelerator, wherein the controller monitors vehicle characteristics and adjusts the motor response to manipulation of the accelerator based upon at least one of the vehicle characteristics.

10. The system of claim 9, wherein one of the vehicle characteristics is heat in the motor and the controller increases the motor response as the heat increases.

11. The system of claim 9, including a fuel cell that provides power to the motor and wherein the controller determines a charge level in the fuel cell and increases the motor response as the charge level decreases.

12. The system of claim 9, wherein the controller determines a first level of performance responsive to a first manipulation of the accelerator at a first vehicle characteristic condition and the controller adjusts the motor response to achieve the first level of performance responsive to the first manipulation of the accelerator at a second vehicle characteristic condition.

13. The system of claim 9, wherein there is a gain associated with the manipulation of the accelerator and the controller adjusts the gain responsive to changes in the vehicle characteristic.

14. The system of claim 9, including an indicator for a driver of the vehicle that indicates a condition where the controller can adjust the motor response responsive to a manual input from the driver.

15. The system of claim 14, including an input switch that is manually operable by the driver to request an increased motor response.

16. The system of claim 14, wherein the indicator includes an audible signal.

17. The system of claim 14, wherein the indicator includes a visible indication.

18. The system of claim 9, wherein the controller determines a condition based upon more than one of the vehicle characteristics and adjusts the motor response based upon the determined condition.

ABSTRACT OF THE DISCLOSURE

An electric vehicle control system controls motor response based upon monitored vehicle characteristics to provide consistent vehicle performance under a variety of conditions for a given accelerator manipulation. In one example, motor temperature is monitored. As the temperature increases, the gain of a power signal provided to the motor is increased to make up for the motor's hindered performance under higher temperature conditions. Other vehicle characteristics that are taken into account include a charge level in a fuel cell or current vehicle speed and engine load.

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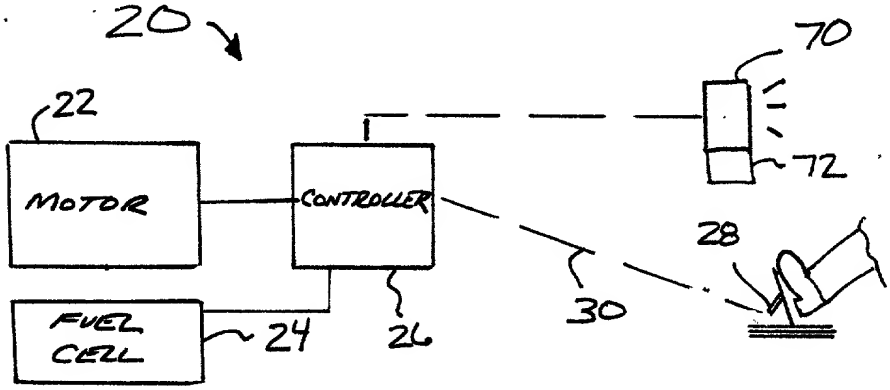

Fig 1

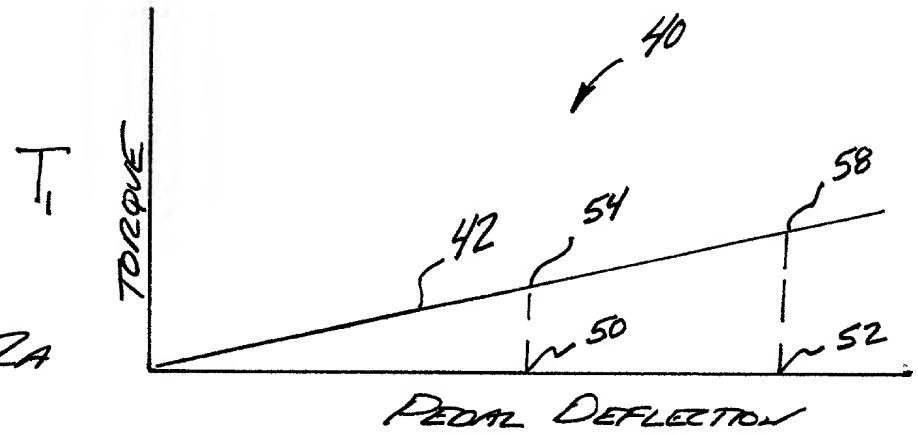

Fig 2A

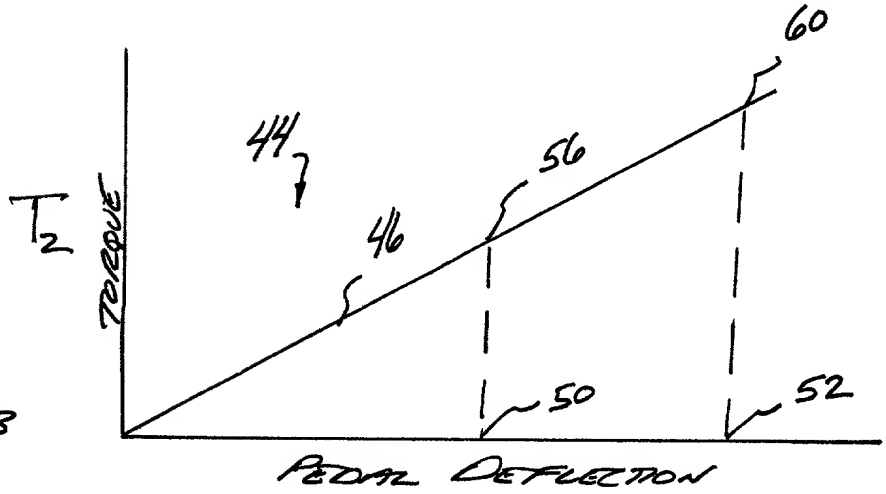

Fig 2B

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☐ Declaration Submitted with Initial Filing OR ☐ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number	99P7786; 60,426-043
First Named Inventor	Paul D. Daly
COMPLETE IF KNOWN	
Application Number	
Filing Date	
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

ELECTRIC VEHICLE CONTROL SYSTEM

(Title of the Invention)

the specification of which
☒ is attached hereto
OR
☐ was filed on (MM/DD/YYYY) _____ as United States Application Number or PCT International Application Number _____ and was amended on (MM/DD/YYYY) _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)
60/152,998	September 9, 1999

☐ Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

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DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

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As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: ☐ Customer Number [ ] → Place Customer Number Bar Code Label here
OR
☐ Registered practitioner(s) name/registration number listed below

Name	Registration Number	Name	Registration Number
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Adel A. Ahmed	29,606	Robert T. Canavan	37,592
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor:	☐ A petition has been filed for this unsigned inventor
Given Name (first and middle [if any])	Family Name or Surname
Paul D.	Daly

Inventor's Signature	Paul D Daly					Date	9/6/00
Residence: City	Troy	State	MI	Country	U.S.A.	Citizenship	U.S.A.
Post Office Address	2166 Joanne						
Post Office Address							
City		State		ZIP	48084	Country	

☐ Additional inventors are being named on the ___ supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

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DECLARATION

REGISTERED PRACTITIONER INFORMATION (Supplemental Sheet)

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